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SMOKE MANAGEMENT IN THE STATE OF MONTANA

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The Air Quality Bureau of the Montana State Department of Health and Environmental Sciences first began considering approaches to reducing smoke from Fall forestry burning in the late 1960's. In the early 1970's, forestry interests and city-county health departments established cooperative programs to control times of burning in several areas of Montana. During the mid-1970's a rather loosely knit State program was organized by the Air Quality Bureau and put into operation, while at the same time a more comprehensive Smoke Management Plan was being developed. The Plan was implemented in 1978 when resources became available to improve meteorological support services to the Plan and to staff a monitoring unit to conduct the program during the Fall burning season. The current Memorandum of Agreement which describes the Plan became effective in the Fall of 1978.

The Agreement has been signed by fifteen agencies and companies representing the major public and private interests who regularly burn slash and other forest residue to assure protection and regeneration of forest areas and for other accepted forest practices, such as wildlife habitat improvement. The objectives of the Agreement are:

1. To minimize or prevent accumulation of smoke in Montana when prescribed burning is necessary.
2. To encourage development of alternative methods to burning.
3. To develop a smoke management plan for reporting and coordinating burning operations on all forest and range lands in the State.
4. To review and evaluate the program at the end of each burning year, and to improve the Smoke Management Plan where feasible.

A statewide organization has been formed to meet these objectives. The State Airshed Group consists of representatives from each of the agencies and companies who have signed the Agreement. This Group meets twice each year to discuss and coordinate the operation of the Plan. Members of the Group are granted an annual air quality permit for burning by the Air Quality Bureau with the proviso that the procedures of the Plan are followed and its requirements met.

The State of Montana has been divided into ten airsheds, whose boundaries are mostly natural divisions resulting from the mountain-valley topography of the State. (Figure 1)

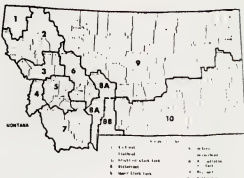


Figure 1. Montana Airsheds

Each airshed has its own local airshed committee consisting of representatives from the agencies and industries conducting wildland burning within that airshed, the local health department, and others interested in air quality. This committee meets at least once each year to discuss and coordinate smoke management in the airshed. The chairman, as the local airshed coordinator, represents the committee in the State Smoke Management Plan and plays an active role in the operational program each Fall season.

To meet a primary purpose of the Montana Smoke Management Plan, i.e. to minimize or prevent accumulation of smoke in the State when prescribed burning is necessary, controls over burning are essential. In the Montana program these controls are based upon meteorological conditions, air quality conditions, and the amount and location of proposed planned burns.

Each day during the Fall burning season a forecast of meteorological conditions for the airsheds is weighed along with the proposed amount of burning to be accomplished in order to ascertain whether burning restrictions should be imposed to keep smoke accumulation from reaching objectionable proportions. For example, marginal dispersion conditions do not require restrictions in an airshed where limited burning in rather remote areas is planned. But, the burning of substantial acreage from which smoke is likely to drift toward quite densely populated areas is not permitted during marginal dispersion conditions. In the mountain-valley topography of western Montana, smoke dispersion, or atmospheric ventilation, conditions often vary significantly with elevation. Burning restrictions are more frequent at elevations within a couple of thousand feet of the major valley floors than at higher elevations.

Wildland prescribed burning in the forests of Mon-

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tana is largely accomplished in the Fall season, after the Summer high fire danger has passed. The Montana Smoke Management Plan is implemented during the three-month period (September-November) by a monitoring unit located at Missoula, Montana. Here a certified consulting meteorologist employed by the State Air Quality Bureau works with a forester specializing in fuels management employed by the State Division of Forestry. This team provides real-time information about restrictions on burning to participants in the Plan. Burning restrictions are relayed to local airshed coordinators by 4PM of the day prior to their being placed in effect, so that firm plans for burning 'tomorrow' can be made 'today'.

Prior to the start of the Fall burning season, each participant in the Smoke Management Plan provides the monitoring unit with a listing of planned prescribed burns that season, their size, type and location. These planned burns are identified by number for future reference. During the burning season the local airshed coordinator is notified of the burn plans for the next day or two by participants in his airshed, and he relays this information promptly to the monitoring unit. It is also the responsibility of the airshed coordinator to establish the necessary communications within his airshed to disseminate the word on restrictions that he receives from the monitoring unit by 4PM each day.

The meteorological support services available to operate the program are provided by the National Weather Service (NWS) fire-weather forecasters at Missoula and Billings; state-employed observers at Missoula, Kalispell and Anaconda who track balloons equipped with temperature sensors; and the Air Quality Bureau meteorologist at the monitoring unit. The NWS forecasters issue daily forecasts for thirteen Montana zones to forestry interests in the State. These forecasts are disseminated via a state teletypewriter circuit and are available to the monitoring unit. The balloon soundings, released shortly after sunrise on weekdays, are relayed to the monitoring unit, where the runs are plotted, reduced and coded for transmission to the NWS office in Missoula. These soundings provide a profile of winds and temperatures in the lower atmosphere and are of great assistance in determining atmospheric stability, its variations and trends.

During the Fall season the fire-weather forecasters include a general smoke dispersion forecast in their service package. In the mid-afternoon, whenever present or forecast smoke dispersion conditions are less than favorable, the monitoring unit meteorologist visits the Missoula NWS Office to discuss the need for issuing burning restrictions, based upon projected meteorological conditions for the next day. Upon his return to the monitoring unit, he and his forester partner review the meteorological prognosis, the planned burns for the following day, reports about air quality that have come in to the unit from airshed coordinators, health department offices, or crews performing burns that day. Then, the monitoring unit team determines if and where burning restrictions are appropriate the next day, and issues such restrictions to all airshed coordinators by 4PM.

The voluntary, cooperative nature of the Montana Smoke Management Plan should be emphasized. Burners

agree to curtail their burning if, in their opinion, their portion of an airshed is becoming overloaded with smoke, or local weather factors are likely to create smoke problems, even though no burning restrictions have been issued by the monitoring unit. Participants have generally demonstrated that they are willing to honor the restrictions imposed, and that they do want to take positive steps to reduce smoke accumulation.

The success of the Montana Smoke Management Plan depends in a large measure upon being able to accomplish the necessary forestry burning during periods of good or excellent smoke dispersion. The number of days of favorable smoke dispersion varies from year to year, and such days become increasingly scarce as the Fall season progresses. Days of relatively poor smoke dispersion were unusually frequent during November 1979, when all or portions of western Montana airsheds had burning restrictions in effect on fourteen (14) days. The Montana Smoke Management Plan has been established statewide, but about 80% of the slash and forest residue acreage burned each Fall season occurs in Airsheds 1 through 6 (see Figure 1), where the smoke accumulation problems are most common and where atmospheric ventilation conditions usually are much poorer than throughout the central and eastern portions of Montana.

An indication of the air quality conditions in western Montana is shown in Figure 2.

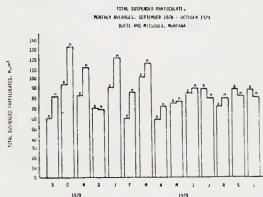


Figure 2. Butte and Missoula Air Quality (TSP)

Since wildland prescribed burns are virtually completed by mid-December (often by December 1), the winter levels of total suspended particulates (TSP) reflect no contribution from forestry burning. In Montana we do not yet have the instrumentation or technology to determine what contribution that Fall forestry burning makes to the monthly values shown in Figure 2.

During September 1978 and 1979 there were no burning restrictions issued in Montana because atmospheric ventilation conditions were generally good during the afternoons, when most burning is done, and because high or moderate fire danger in the forests delayed much of the large-scale prescribed burning until later in the season. In comparing daily TSP values at Missoula for October and November 1978 for restricted and non-restricted burning periods for Airshed 3 (where Missoula is centrally located), the TSP levels averaged $166 \mu g/m^3$ for the restricted days and $104 \mu g/m^3$ for the non-restricted days. In 1979 these aver-

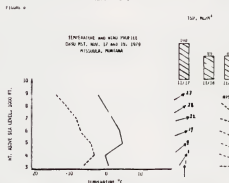
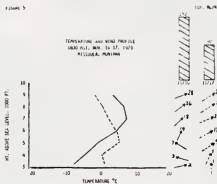
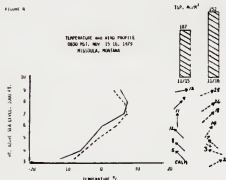
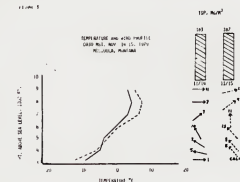
ages were 143 and 84 respectively. When air pollution levels were high as a result of poor atmospheric ventilation, forestry burning was restricted.

The goal of the monitoring unit is to anticipate the onset of periods of poor smoke dispersion and to impose burning restrictions BEFORE smoke concentrations reach objectionable proportions. The unit also makes every effort to lift restrictions as soon as improved ventilation, or dispersion, conditions are imminent.

The addition of the state-operated balloon soundings at Kalispell (Airshed 2), Missoula (Airshed 3) and Anaconda (Airshed 5) contributes to a better understanding of meteorological variations in western Montana. A fourth station at Bozeman (Airshed 8A) is planned for the Fall of 1980. The meteorological evolution of deteriorating and improving ventilation conditions in the mountain-valley topography of western Montana can be better understood by reviewing and studying the atmospheric variations that occur and associating those changes with the synoptic weather patterns that produce them.

Figures 3, 4, 5 and 6 show the wind (MPH) and temperature ($^{\circ}\text{C}$) profiles over Missoula for November 14 through 19, 1979, (excepting Sunday, November 18). During this period the top of the temperature inversion slowly lowered from about 8000 feet MSL the morning of the 15th to the valley floor late in the day on the 18th, and daily maximum temperatures did not exceed 4°C .

In these same figures daily total suspended particulate (TSP) values (measured in micrograms per cubic meter) are indicated for each day at the courthouse roof site in downtown Missoula. Burning restrictions were in effect for the area from November 13 through 16.



Figures 3 - 6. Temperature and Wind Profiles and Daily TSP Levels, Missoula, Nov. 14-19, 1979.

Challenges and opportunities for improvement in the Smoke Management Plan exist. In addition to the most obvious, i.e. encouraging development of alternative methods to burning, a few others are:

1. Identifying, documenting and studying the meteorology of local variations in atmospheric ventilation, or smoke dispersion.
2. Utilizing techniques in burning and fuel preparations that make the job as smokeless as possible.
3. Viewing the smoke management program as a 6 or 7-day-per-week operation, rather than the 4 or 5-day-per-week operation that is now dominant.
4. Providing necessary fire safety support to promote late August and early September burning, when smoke dispersion is normally much better than later in the Fall.

Most opportunities for improvement in the Montana Smoke Management Plan cost money. However, at a relatively minor cost some improvements may be possible through assigning a higher priority to the importance of accomplishing the task of burning as effectively and efficiently as is possible making maximum use of the periods of good or excellent smoke dispersion. Montana participants have responded enthusiastically to suggested improvements in the Plan; their continuing support augurs well for the future.

